ISSN: 2278 – 7798
International Journal of Science, Engineering and Technology Research (IJSETR)
Volume 5, Issue 10, October 2016

DESIGN AND ANALYSIS OF DOWN THE HOLE HAMMER USING CREO 3.0

P VAMSI KRISHNA[1], V. NAGESHWAR RAO[2], D.V. SRIKANTH[3]

PG Scholar, St. Martin's Engineering College, Hyderabad, Telangana, India.
Assistant Professor, St. Martin's Engineering College, Hyderabad, Telangana, India.
Professor, St. Martin's Engineering College, Hyderabad, Telangana, India.

***Abstract*— DTH is short for "down-the-hole". The down-the-hole drilling is used to produce large-diameter holes or bores in to the hard rock surfaces of earth crust. DTH drilling is useful producing of either straight holes as well as direction holes. This paper deals with complete modeling, assembling and analysis of DTH hammer. The subject of abstract is to design the parts of hammer like barrel, bit, piston and then analyze for its static analysis in Ansys made out of selected materials. DTH Hammer consisting of different parts in which barrel is the main element holds and transfer the energy needed for drilling. It also support and withstand to the impact of the piston and drill bit for breaking the materials like sand, granite, rock etc. So, the performance of the barrel is taken to task for study of this project work with different material used for withstanding various operating conditions of drilling the above materials in dry or wet condition.**

***Key words:* AISI SS Grade 310, Barrel, Button Bit, Down the hole, EN 36C**

I. INTRODUCTION

A Down-the-Hole drill, usually called DTH by most professionals, is basically a mini jack hammer screwed on the bottom of a drill string. The fast hammer action breaks hard rock into small flakes and dust and is blown clear by the air exhaust from the DTH hammer. The DTH hammer is one of the fastest ways to drill hard rock.The Down-the-Hole Hammer drill is a percussive device in cylindrical form with integral drill bit that is fitted directly onto the bottom of a drill string. DTH is one of the most efficient ways of drilling rock, using a rapid hammer action to break the rock into sizeable chips which are then evacuated from the bore hole by the air exhausted from the DTH Hammer. The technique provides fast drilling of accurately aligned, straight and clean holes in most ground conditions.

DTH is short for "down-the-hole". The down-the-hole drilling is used to produce large-diameter holes in rocks, usually in the initial stage prior to blasting, but it is also used in non-blasting applications. DTH drilling are used mostly in mining quarries but can be used in a variety of other construction applications. The DTH drilling method is growing in popularity, with increases in all application segments, including blast-hole, water well, foundation, oil & gas, cooling systems and drilling for heat exchange pumps. Applications were later found for the DTH method underground, where the direction of drilling is generally upwards instead of downwards. In DTH drilling, the percussion mechanism commonly called the hammer is located directly behind the drill bit. The drill pipes transmit the necessary feed force and rotation to hammer and bit plus compressed air for the hammer and flushing of cuttings. The drill pipes are added to the drill string successively behind the hammer as the hole gets deeper. The piston strikes the impact surface of the bit directly, while the hammer casing gives straight and stable guidance of the drill bit. This means that the impact energy does not have to pass through any joints at all.

DTH products can be used in the following applications: Mining- Drill & Blast holes in Open Pit mining, Where the drill operator will drill several holes, then fill with explosives and detonate to lift rock allowing access to ore body RC-Exploration & Pit grade control GW- Geothermal Bore Holes & Waterwells Oil & Gas- Deepwell Bore Holes Construction-Piling, Footings.

II. PARTS OF DTH HAMMER

1. BARREL

The case is designed to contain the internal parts which make up the hammer assembly. The case is reversible and hardened to resist wear and to extend life in abrasive conditions. Wrench flats are provided for disassembling.

Fig. 1: Barrel

All Rights Reserved © 2016 IJSETR

2. TOP VALVE (Air Distributor)

The Air distributor guides the check valve and the check valve spring. The main air supply is directed to the control through the ports located in the air distributor.

3. CONTROL TUBE

The Control tube supplies the main air in to the chambers located in the piston. It seats on a shoulder in the air distributor and is designed with a long bearing surface to maintain alignment in the air distributor.

4. PISTON

The Piston functions as the only moving part in the hammer, controlling the operational air cycle. The percussive action of the piston striking the bit transfers the energy through the bit in order to fracture rock formation.

Fig 2: Piston

5. BUSH

The Retainer bush guides the bit to insure proper alignment between the piston and the bit. The DTH Hammer Retainer Bush is pressed in to the chuck end of the case to provide a seal for the main air supply. The bit bearing is located by a snap ring which is inserted in the main bore.

6. BUTTON BITS

Down-the-hole drill hammer bits are used with Down-the-hole hammers for drilling holes through a wide range of rocks types. In conjunction with DTH hammers, drill hammer bits are designed with a splined drive for rotating the bit in the ground. Drill bits are available in different sizes and different styles so they can drill a wide range of hole sizes.

Fig 3: Button Bit

7. CHECK VALVE

The check valve maintains pressure in the hammer when the air supply has been shut off. The pressure in the hammer balances the hydrostatic pressure in the hole there preventing contaminants from entering the hammer.

8. FRONT CHUCK

Front chuck threads in to the bottom end of the cylinder with the large cross section thread form. It has internal splines that transmit rotation to the bit through a set of delrin drive plates.

9. BIT LOCK

The Bit locks are designed to allow the bit to move between the drilling and cleaning positions and prevent the bit from coming completely out of the hammer. The bit retaining rings consist of two matched halves and are held together with the bit retaining ring – o –ring.

III. Drilling Cycle

Air enters the hammer through a bore in the backhead, opens a rugged check-valve, and flows through holes in the valve chest into the control tube. Channels carry the air from here down into a port where it continues flowing down air passages in the piston to finally reach the lower chamber. Pressure created by the air influx forces the piston to move upward.

Upward motion continues until the piston pulls off the stationary foot valve; this allows air flow from the lower chamber through the bit and into the borehole area being drilled. Immediately after the lower chamber is exhausted, the top of the piston recess aligns with the port to allow air flow through the piston’s top outer passages into the upper chamber. This chamber has been sealed by the piston passing over the end of the control tube . The air pressure then decelerates piston movement quickly but smoothly, and piston motion reverses before the piston strikes the control tube. As downward motion starts, and just prior to the piston striking the bit, the upper chamber begins to exhaust.

Upon impact, the cycle is immediately repeated. The bit moves freely in the chuck splines so that full impact force is transmitted to bit cutters to produce formation chips. When the hammer is lifted off the bottom, the bit drops to an extended position with it’s top shoulder resting on a retainer ring. The piston rests on top of the bit and does not oscillate.

This “at rest” action is provided by full air volume being directed through the piston bore. In this way, the driller can blow water from the hole and accelerate periodic borehole cleaning as and when necessary.

All Rights Reserved © 2016 IJSETR

IV. Material Used for Hammer and Bit

1. EN36 is a 3% nickel, chromium, molybdenum grade which is suitable for deep hardening to develop a tough core. EN36 is characterised by high core strength, excellent toughness and fatigue resistance, is is used in components that require high surface wear resistance, high core strength and good impact properties. EN36C gives a hard case with a strong core, whilst retaining a remarkable degree of toughness.

Properties of EN36c:

i. Physical Properties:
Density = 7.85 g / cc

ii. Mechanical Properties:
Hardness= 40 HRC
Ultimate tensile strength = 1238 Mpa
Yield tensile strength = 993 Mpa
Elongation at break = 200 Gpa
Modulus of elasticity = 200 Gpa
Bulk modulus = 140 Gpa
Machinabilty = 50 %
Shear modulus = 80 Gpa

iii. Thermal Properties:

CTE = 11.5 mm/m oc
Specific heat =0.472 J/g ^{o}C
Thermal conduction = 51.9 w/n-k

Composition of EN36C:

C = 0.12 %
Mn = 0.30 %
Si = 0.10 %
Cr = 0.60 %
Ni = 3.19 %
Mi = 0.14 %
S = 0.05 %

2. AISI Stainless Steel 310, combining excellent high temperature properties with good weldability and ductility, is designed for high temperature service. SS 310 resists oxidation in continuous service at temperatures up to 1150°C provided reducing sulfur gases are not present. SS 310 is also used for intermittent service at temperatures up to 1040°C.

Properties of SS 310:

Density = 8.0 g/cc
Tensile Strength = 75000Psi
Yield Strength = 30000Psi
Ultimate tensile strength = 1238 Mpa
Yield tensile strength = 993 Mpa
Elongation at break = 200 Gpa
Modulus of elasticity = 200 Gpa
Shear modulus = 77 Gpa
Specific heat =0.5 J/g ^{o}C

Composition of AISI SS 310:

C = 0.25 %
Mn = 2 %
Si = 1.5 %
Cr = 24 - 26 %
Ni = 19 - 22 %
Mi = 0.14 %
S = 0.03 %
P = 0.045%

V. Modeling and Analysis of DTH Hammer Parts

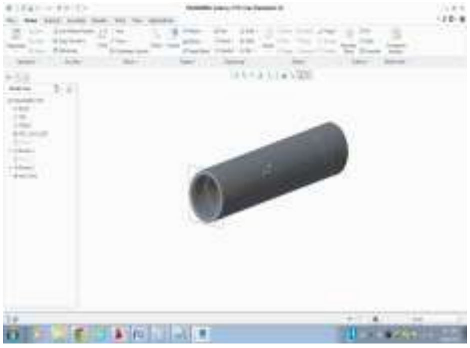

Fig 4: 3D Model of Barrel in Creo 3.0

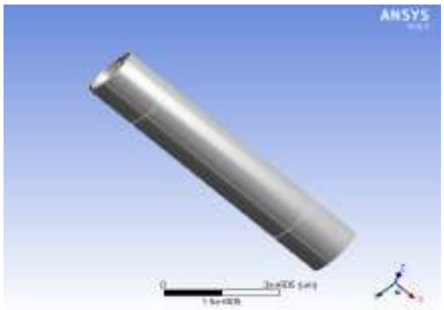

Fig 4: Base Model of Barrel in Ansys

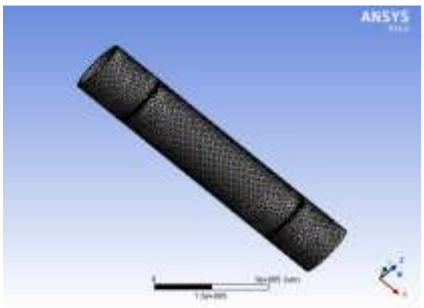

Fig 5: Mesh model of Barrel

All Rights Reserved © 2016 IJSETR

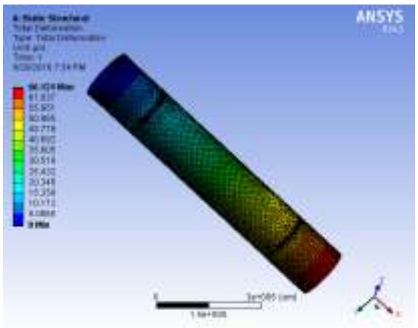

Fig 6: Structural analysis of Barrel(EN 36C material)

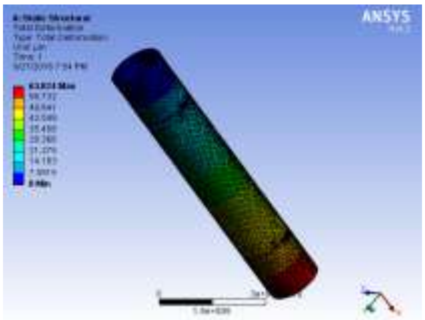

Fig 7: Structural analysis of Barrel (AISI SS Grade 310)

Table 1: Factor of safety of AISI SS Grade 310

S.No	Hammer Part	Factor of Safety			
		Brick	Granite	Lime Stone	C.Concrete
1.	BARREL	16.85	9.63	22.47	33.70
2.	PISTON	6.57	3.75	8.76	13.14
3.	BIT	4.86	**2.78**	6.48	9.72

Table 2: Factor of safety of EN 36C material

S.No	Hammer Part	Factor of Safety			
		Brick	Granite	Lime Stone	C.Concrete
1.	BARREL	16.91	9.66	22.54	33.81
2.	PISTON	6.60	3.77	8.80	13.20
3.	BIT	4.84	**2.77**	6.46	9.68

VI. CONCLUSION

Based on the modeling and analysis software like CREO 3.0 and ANSYS some of the results are obtained. These results are taken based on the Von-Mises stress and deformaton values of each material used in the manufacture of DTH Hammer. Among all these materials, AISI SS Grade 310 material gives least factor of safety and deformation than that of the remaining materials. Hence the design is good.

ACKNOWLEDGMENT

This paper is based on M. Tech. project carried out by the student of St. Martin's Engineering College, Hyderabad studying M.Tech (Machine Design).The project had been completed by Mr. P VAMSI KRISHNA bearing H.T.no.: 14K81D1506 under the guidance of Mr. V. NAGESHWAR RAO, Associate Professor. I am very much grateful to Prof. Mr. D.V. SRIKANTH, Head of the Dept. of Mechanical Engineering, SMEC for his necessary technical support and stimulated guidance throughout the course of the project work. I take this opportunity to record my obligations to Mr. VENKATESHWAR RAO, Design engineer for his encouragement and in valuable guidance for the development of this project.

REFERENCES

[1] www.rockmore-intl.com
[2] www.rockdrill.co.uk
[3] www.dthrotarydrilling.com
[4] www.drillingrigsindia.com
[5] R. Hamilton P.Makulsawatudum, & D. Meckenzie, "Stress concentration On Dth Button Bit", Journal of Strain Analysis, Vol 4, pp 415-421, 2009.
[6] Teale, R.: "The Concept of Specific Energy in Rock Drilling," International Journal of Rock Mechanics and Mining Science (1999) vol. 5, 821-832.
[7] Li, X., Rupert, G., Summers, D.A., Santi, P. and Liu, D.: "Analysis of Impact Hammer Rebound to Estimate Rock Drillability," Rock Mechanics and Rock Engineering (2000) 33, 1-13.
[8] T. Altan, V. Vazqes, Numerical process simulation for tool and process design in bulk metal forming, Annals of CIRP 45/2 (1996) 599-607.
[9] Chiang, L. E., Elías, D. A., 2000. Modeling Impact in Down-the-Hole Rock Drilling. International Journal of Rock Mechanics and Mining Sciences, 37(4): 599–613

All Rights Reserved © 2016 IJSETR